ACTOR OR EXECUTOR? HOW DOES GENERATIVE AI RESHAPE STUDENT AGENCY IN MATHEMATICS

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Student agency has become a central concept in contemporary mathematics education. This study examines how interaction with Generative Artificial Intelligence (GenAI) reshapes undergraduate students' agency, particularly concerning perception of themselves as 'actors' or 'executors' in their learning process. Using a mixed-methods approach, the analysis revealed different individual trajectories, ranging from an increased sense of active involvement to reliance on GenAI for decision-making, when tasks become complex. The findings suggests that GenAI does not influence agency unilaterally but rather acts as a resource whose outcomes depend on how students choose to engage with the tool.

INTRODUCTION

Student agency has become a central concept in contemporary education, referring to students' ability and willingness to influence their learning processes and educational journey (OECD, 2019). Student agency is generally understood as the degree of autonomy, initiative and sense of control that students experience within their learning environments (OECD, 2019). Fostering agency is considered crucial because it promotes 'learning to learn' skills, essential for lifelong learning. In mathematics education research, student agency is increasingly recognised as a key to moving beyond traditional transmissive approaches and promoting more meaningful, participatory learning (Brown, 2009). From this perspective, agency plays a fundamental role in determining whether students approach mathematical activity as *passive* recipients of knowledge or *active* constructors of meaning.

Building on this perspective, we draw on Jääskelä et al.'s (2017) conceptualisation of student agency, which is based on personal, participatory, and relational resources, offering a comprehensive and operational framework for studying agency in higher education. Jääskelä et al. (2017) define agency as the experience of being able to act within study contexts through various resources that enable intentional and meaningful engagement with learning. Along this direction, in this study, we focus on participatory resources, and investigate students' perceived opportunities to participate actively, express opinions, ask questions, influence learning processes, and make choices. Given the significant challenges to student agency recently posed by the advent of Generative Artificial Intelligence (GenAI) (Pepin et al., 2025), we aim to understand how students' participatory agency manifests and is interpreted in GenAI-integrated learning environments. Rather than examining the effectiveness of GenAI, our lens explores how interaction with it reshapes undergraduate students' perception of themselves as

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'actors' or 'executors' of their own learning. We adopt an interpretative approach to examine how various aspects of participatory agency are reflected in students' experiences before and after engagement in GenAI-supported activities.

RELATED LITERATURE

Agency in education has been conceptualised as a dynamic phenomenon, such as Pickering's (1995) metaphor of the 'dance of agency', which captures the tension between human agency, understood as individual initiative and creativity, and the agency of the discipline, which manifests through constraints, structures, and conventions. In educational contexts, Wagner (2007) and Boaler and Greeno (2000) have further elaborated on this tension, arguing that traditional pedagogical approaches often limit students' 'authoring space', positioning them as passive learners rather than active creators of ideas. Conversely, agency emerges through learning environments that incorporate open-ended tasks, interaction, discourse and collaborative inquiry, fostering active student participation in shared mathematical practices (Brown, 2009; Nieminen et al., 2022).

Recently, attention has shifted towards the role of material and technological resources in shaping agency (e.g. Pepin et al., 2024). From this perspective, agency emerges from the interaction between students and the resources available to them, rather than residing exclusively within the individual (Carlsen et al., 2016). Pepin et al. (2024) propose interpreting student agency through the lens of resources, drawing on the Instrumental Approach (Trouche, 2004). Here, agency becomes visible in processes of instrumentalisation, where students adapt resources to their needs, and instrumentation, where resources influence students' ways of thinking and acting. This interaction leads to the concept of *distributed agency* (Pepin et al., 2024), a perspective we adopt, in which initiative is shared between students, teachers, tools, and the discipline itself.

Integrating GenAI tools into learning practices introduces a qualitatively different resource: interactive, adaptive and dialogic. Unlike traditional digital resources, GenAI offers personalised responses and sustained engagement (Pepin et al., 2025). From an agency perspective, GenAI has the potential to enhance students' sense of participation by encouraging them to engage in activities such as exploration, questioning, taking the initiative, and making choices. However, it can also guide, constrain or replace students' decision-making processes, raising questions about authorship, responsibility and influence in GenAI-mediated learning activities (Pepin et al., 2025), which we focus on in our study.

THEORETICAL FRAMEWORK AND RESEARCH QUESTION

Jääskelä et al. (2017) identify three main domains of resources that constitute student agency: (i) *Personal*, (ii) *Relational* and (iii) *Participatory*. Personal resources include self-efficacy and beliefs of competence; Relational resources concern power dynamics, trust in the teacher and peer support, while participatory resources encompass factors that enable active participation and the perception of influence over learning process.

The study focuses specifically on the domain of participatory resources, exploring factors related to participation and opportunities for choice and influence. According to this perspective, the first factor, 'participation activity' has a dual nature. It reflects the student's individual actions to participate actively (e.g. asking questions and expressing opinions) and captures contextual opportunities that facilitate participation (e.g. perceived 'ease of participation'). In mathematics education, this concept is linked to the 'authoring space' (Boaler & Greeno, 2000), where students move from passive receivers to active contributors to mathematical discourse. Contextual support for agency is also represented by the 'opportunity to influence' and 'opportunity to make choices'. While the first factor concerns the 'right to have a say' on content and teaching methods, the second factor concerns autonomy in managing one's own learning path. In our study, we consider these factors together to determine whether students position themselves as the 'author' or 'executor' of their own learning.

In line with Jääskelä et al.'s (2017) construct, this study explores GenAI's function as a resource capable of reshaping students' participatory dynamics through two opposing potentials. First, interaction with GenAI can act as an effective scaffolding tool, serving as a dialogical and non-judgemental dialogic partner. This feature can encourage students to formulate critical questions and explore avenues of enquiry that might otherwise remain unexplored. In this sense, the tool increases the 'ease of participation', offering a safe space in which to take the initiative and test one's intuitions, free from the social pressures of classroom discourse. Conversely, interaction with GenAI can also take the form of an invisible constraint, limiting creativity rather than nurturing it. If students perceive the tool as authoritative or receive responses that close off reflection by offering predefined solutions, their participatory agency risks being weakened. In such circumstances, students may adopt a passive role, merely following suggestions without critically negotiating meanings – a tension that our research seeks to explore.

The theoretical and educational challenge therefore lies in determining whether GenAI facilitates a space for authorship or replaces decision-making processes, thereby redefining the boundary between active learners and passive executors of predefined paths. Building on these premises, the research aims to reinterpret the factors of participatory resources in light of interaction with GenAI. The tension between being an actor and an executor is the central lens through which we understand how participatory agency evolves in undergraduate students. By analysing how they report their experience of participation influence, and perceived ease of engagement, the study seeks to explore how GenAI can expand or limit students' opportunities for action. In line with this, our study addresses the following research question (RQ): *How does interaction with GenAI reshape undergraduate students' perception of themselves as 'actors' or 'executors' within their mathematical learning process, particularly in relation to participatory resources?* Specifically, we will seek to understand whether interaction with GenAI has expanded or restricted the participatory dimension of student agency during GenAI-mediated course activities.

METHODS

The study involved 11 undergraduate students enrolled in the "Complementary Mathematics" course. The course was divided into two distinct phases: the first phase used traditional teaching methods (lectures and teacher-led discussions) without GenAI and the second integrated GenAI tools into laboratory activities focusing on topics such as graph theory, geometric transformations, infinity and taxicab geometry. During the latter phase, students were encouraged to interact with a chatbot to explore conjectures, visualise problems, and negotiate mathematical meanings.

The research employed a mixed methodology, incorporating questionnaires and semi-structured interviews. The questionnaire was based on the Agency of University Students (AUS) scale developed by Jääskelä et al. (2017). The original 58-item questionnaire was reduced to a targeted selection of 25 items that were identified as most relevant to GenAI integration. These items were rated using a four-point Likert scale designed to explore the degree of agreement or perceived frequency: 1 (Not at all), 2 (A little), 3 (Quite a bit) and 4 (A lot). A four-point scale was chosen, without a neutral central value, to encourage students to clearly position themselves in relation to the statements. The questionnaire was administered twice: once midway through the course, at the end of the traditional phase, and again at the end of the course, after the GenAI-integrated activities. This study focuses on the participatory dimension of agency (11 items), examining four factors: participation activities (individual initiative in asking questions and making comments); ease of participation (perception of the simplicity of intervening in discussions); opportunities to influence (perception of being able to influence methodologies and content); opportunities to make choices (autonomy in managing teaching tasks). Items are showed in Figure 1.

Figure 1: Items of the questionnaire related to the participatory dimension of agency

Factor	Number	Item
Participation activity	4	How much responsibility can you take for being an active participant
	5	How much can you ask questions and make comments during the course
	6	How well can you express your thoughts and opinions during the course
Ease of participation	7	How easy do you find it to participate in discussions
	8	How much difficulty do you experience in participating in discussions
	9	How courageous do you think you are in questioning the issues presented in the course
Opportunities to influence	10	How much do you think your point of view and opinions are taken into consideration
	11	How much do you think you have the opportunity to influence working methods
	12	How much do you think you have the opportunity to influence how competence is assessed in the course
Opportunities to make choices	13	How much do you think you have the opportunity to influence the course content
	14	How much do you think you have the opportunity to choose the course content based on your interests

Individual semi-structured interviews were conducted at the end of the course to

explore the reasons for the changes observed in the questionnaires. The analysis for the present study focused exclusively on the participatory dimension, and aimed at exploring three core aspects: participation, influence, and choice. To observe the aspect of participation, students were asked to reflect on their frequency of intervention and how the tool influenced their willingness to take the lead (e.g. 'Did you feel like an active participant? Has the use of GenAI influenced the way you take initiatives?'). The aspect of influence was examined by probing whether students felt empowered to shape the direction of the tasks (e.g. 'Has the experience with GenAI changed your sense of control or influence in your learning journey?'). Finally, the aspect of choice was observed by analysing the tension between self-directed study and reliance on the tool (e.g. 'Did GenAI make you more independent or more dependent? Has its introduction enhanced or limited your ability to act/make choices?'). Furthermore, students were asked to describe 'critical episodes' where GenAI functioned either as a supportive scaffolding or a restrictive constraint. The process involved the transcription of the interviews and the identification of the parts related to participation, influence and choice. These segments were assigned descriptive labels (codes), which were subsequently grouped into broader sub-categories. Finally, these sub-categories were synthesized into two thematic areas that summarise emerging tensions: Agency as empowerment, reflecting the student's role as a conscious 'actor' and agency as a constraint, representing the shift toward the role of an 'executor'. The coding scheme is summarised in Figure 2.

Figure 2: Relationship between data segments, sub-categories, and the thematic areas

Theme	Sub-Category	Code	Data segments
Agency as empowerment (role of actor)	Method customization	Autonomous discovery management	I manage discovery with my own method.
		Cognitive efficiency	Genai can make a job faster and then make the work itself independent and autonomous.
	Social and affective mediation	Validation for security	I test the idea with AI to feel more confident.
		Strengthening of the participatory voice	Knowing how to use AI gives me a cue to interact.
	Critical knowledge supervision	Error negotiation	I know that he made a mistake… I look for confirmation elsewhere.
		Access to intuition	Understanding the intuitive idea that I would not arrive at alone.
Agency as constraint (role of executor)	Decision-making delegation	Yielding perseverance	I gave autonomy to the AI because I was tired.
		Passive reliance	If I see that I can't do it, I see that I need help, then I rely on AI to study.
	Instrumental addiction	Constrained path	I follow the paths suggested by the algorithm.
		Immediate use of the tool	By now when I study, I always have to stay with the computer on, if I have a doubt, I look for it on ChatGPT.

To ensure anonymity and methodological rigor, students used nicknames, allowing responses from the two questionnaires to be matched with interview data without collecting personal identifiers (e.g. names, student IDs, or emails). An external

researcher, who was not the course lecturer, collected quantitative data and conducted interviews to prevent any influence on final exam assessment. The analysis involved cross-referencing quantitative data and qualitative evidence. Firstly, individual variations in scores for the 11 items in the participatory dimension were mapped. These trajectories were then examined in depth through interview analysis. Three emblematic cases, here renamed as Pink, Cian and Blue, were selected to illustrate different trajectories of participatory agency reshaping.

RESULTS

Results across the participatory items point to a heterogeneous landscape of students' experiences. Rather than a linear progression, the findings highlight diverse trajectories, ranging from enhanced agency to stability or decline. Such varied results demonstrate that GenAI's role in shaping agency is not uniform, but rather shaped by the unique circumstances of each individual. To illustrate the qualitative analysis of the interviews, we present three cases, selected for their distinct trajectories, that are emblematic of the diverse impact of GenAI on student agency: Pink, who strengthened autonomy in the discovery process by using GenAI to personalise learning; Cian, who searched for secure mediation to overcome communication barriers and participate in a more protected way; and Blue, who partially delegated decision-making processes and passively relied on the tool when faced with tasks of high cognitive complexity.

Pink's case is an emblematic example of how agency can evolve into active protagonism. The results show a significant increase in participatory dimension items. Quantitatively, there is a net increase in responsibility for being an active participant (response to I4 increases from 3 to 4) and in the perception that her opinions are valued (I10 increases from 3 to 4). Even more striking is the increase in opportunities to influence content and methodologies (I11 rises from 2 to 3, I12 from 1 to 3, I13 from 2 to 3), indicating a shift from marginality to active control. In the interview, Pink links this change to the opportunity to overcome teaching methods, seen as 'imposed from outside', and to create a personalised learning journey based on her own 'way of thinking'. For Pink, GenAI is a tool that can speed up manual work and free up space for intuitive understanding. By stating that she manages her own discovery with her own method, Pink positions herself as a deliberate user of GenAI who expands her space of authorship while maintaining critical oversight over the results. In doing so, she positions herself more strongly as an actor in her mathematical learning process.

Cian's case reveals a different trajectory, with a discrepancy between the communicative and decision-making dimensions of agency. While the data indicates an increase in ease of participation and confidence in expressing opinions (I5 and I6 increase from 1 to 2), it also shows a decrease in the perception of having the ability to influence or select course content (I10 decreases from 3 to 2; I13 decreases from 2 to 1; and I14 decreases from 3 to 1). Cian describes this tension, explaining that he views GenAI as a 'non-judgemental' dialogical partner that validates his insights. However, using technology as a 'shield' to overcome shyness carries a risk. Cian participates

more because he feels protected by the tool; however, it is precisely this search for security that leads him to delegate to the tool the control of correctness. In this sense, although Cian is more active in the discussion, his participatory agency is reduced in terms of choice. His perception of the ability to influence his learning direction is reduced by his fear of making mistakes, which causes him to follow GenAI.

Finally, Blue's case illustrates that participatory agency is not a stable trait, but rather a resource that varies according to the complexity of the task. Although he initially shows openness towards the tool, perceived as enhancing his study method (I11 goes from 2 to 3), the interview reveals a rupture coinciding with mathematically demanding tasks. In such circumstances, Blue admits to having 'given more autonomy to ChatGPT' due to fatigue and difficulty with visualisation. This transition is crucial: participatory agency, understood as intentional engagement in the process, breaks down, and the student is forced to take on the role of executor. GenAI ceases to be a catalyst for thought and instead becomes a refuge that enables the task to be completed without any meaningful negotiation. Therefore, Blue's trajectory suggests that the ease of use of GenAI can encourage the delegation of decision-making responsibility when mathematical challenges become more demanding.

CONCLUSIONS AND DISCUSSION

In response to the research question, the study demonstrates that interaction with GenAI reshapes participatory agency by placing the student in a constant dynamic tension between the roles of actor and executor, in line with the notion of the 'dance of agency (Pickering, 1995). GenAI not only acts as an enhancer, but also as a resource whose outcomes depend strictly on one's position in relation to the tool. In line with Pepin et al. (2025), it can expand agency when it facilitates personalised knowledge, but it can also constrain it when it is used to replace cognitive effort or as an external validator of truth. The main results highlight divergent individual trajectories ranging from strengthening autonomy in the discovery process (Pink), to the search for a safe mediation to overcome communication barriers (Cian), up to a partial delegation of decision-making processes in the face of highly complex tasks (Blue). Clearly an increase in 'ease of participation' does not automatically guarantee an increase in the decision-making responsibility or student's opportunity of choice. Revisiting the framework of Jääskelä et al. (2017), the analysis of participatory resources has proved to be an effective lens for mapping behavioural changes; however, the integration of GenAI suggests that critical negotiation and the maintenance of epistemic authority, i.e. the ultimate control over the validity and correctness of content, should be considered determining factors for the exercise of agency in digital contexts. These results indicate that agency is not an acquired state, but a dynamic equilibrium that requires the student to use the tool as *scaffolding*, without delegating to it the responsibility of deciding the correctness of the results. As a next step, we intend to expand the sample to verify the persistence of these trajectories and investigate how the prolonged use of GenAI also affects the personal and relational dimensions of the

agency. This will allow us to outline a more complete model of student agency in the age of artificial intelligence.

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